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Holding Power of Drift Bolts

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HOLDING POWER OF DRIFT BOLTS

...BY...

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

HOWARD BRUCE MURPHEY

ENTITLED HOLDING POWER OF DRIFT BOLTS

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Civil Engineering

HEAD OF DEPARTMENT OF Civil Engineering

Introduction.

A drift-bolt is a plain rod used to fasten timbers together, in the place of ordinary bolts. The rods are driven into holes of slightly smaller diameter and hold by the friction thus produced. It is from this fact that the name is derived, a drift in mechanics being the difference between the size of a bolt and that of the hole into which it is driven.

The rods used as drift-bolts may be round or square, and each of these forms may be barbed or smooth. The object of the barbs is to increase the adhesive power of the bolt when driven into the wood. Formerly the square and jagged form was common, but within the last twenty years it has been demonstrated that the smooth round rods are best.

Comparatively few tests have ever been made regarding the holding

power of drift bolts; and since they are so extensively used in timber trestles, pneumatic caissons, grillages for bridge piers, ship building, etc., it is important that some reliable data on the holding power be obtained. This is especially true in grillages and pneumatic caissons, for as these are sunk into their places the buoyant effect of the water is considerable and tends to pull apart the drifted timber work. To illustrate the extent to which drift bolts are used, a table of dimensions and quantities of materials used in the pneumatic foundations of the Havre de Grace bridge* shows that for one pier more than twenty-nine tons of these bolts were required.

In the hope of obtaining data that will be of some value to the engineering profession, the following experiments were made. The conditions and materials used were made

* Baker's Masonry Construction.

to resemble, as nearly as possible, those those encountered in actual practice

Methods and Materials

The timbers used were sound blocks of seasoned white oak and white pine; twelve inches by twelve inches by two feet. The holes were bored by hand, and in diameter varied by 16ths from 15/16 of an inch down to and including 11/16. The holes transverse to the grain were bored twelve inches deep, and those parallel to the grain six inches. Care was taken that the axes of the holes should be as nearly perpendicular to the face of the block as possible so that when the block was placed in the testing machine, the force applied should act in a line parallel to the axis of the hole. No extra precautions, however, were taken that would be impossible or impracticable to workmen in actual construction.

A 1-inch smooth, round, steel rod was marked and driven, with

a sledge, into the hole. The block was then put into the Philadelphia testing machine and the rod drawn out in the same direction from which it was driven.

At the first perceptible movement of the rod, the force was recorded as the power required to start the bolt. After that, readings were taken at each inch until the rod was completely withdrawn.

The above process was carried out for each test. Two complete sets of tests were made with the oak and one with the pine.

Table I

Holding Power - Holes Transverse to the Grain

Test I					
	Seasoned White Oak				
Depth in Inches.	Holding Power in Lbs.				
	15/16"	14/16"	13/16"	12/16"	11/16"
12	18550	28000	28200	29310	30870
11	12280	17900	17070	20630	18610
10	11940	15600	15420	17590	18050
9	9970	14290	12350	14880	15240
8	8770	12410	10680	12890	13750
7	7740	9060	9120	10860	11560
6	6530	7490	8750	7860	8290
5	5110	5490	6370	5600	6720
4	3740	4080	4120	4470	4010
3	2470	3700	3000	3410	2980
2	1500	1480	2000	1770	1260
1	400	210	660	530	200

Test II.					
12	18060	23870	24650	19800	29040
11	14200	16860	14920	12640	17760
10	12890	13400	13050	11830	15450
9	10410	11640	12210	10520	13920
8	9090	10000	10020	9430	12120
7	7570	8440	9270	7920	10290
6	6400	6990	8162	7590	8210
5	5000	5520	5460	6390	6060
4	3680	4000	4360	3970	5260
3	2390	2010	3090	2680	3220
2	960	1540	1400	1800	2170
1	150	150	810	660	720

Table II

Holding Power-Holes Transverse to the Grain

Test I

Seasoned White Pine					
Depth in Inches	Holding Power in Pounds.				
	15/16"	14/16"	13/16"	12/16"	11/16"
12	6020	8910	8970	7300	
11	3790	5050	5000	4920	Blocks
10	3100	4730	4310	4470	split
9	2900	4390	4190	3990	in two
8	2540	3900	3790	3700	cases
7	2020	3380	3080	2980	tried.
6	1710	2810	2740	2580	
5	1280	2300	2210	2000	
4	1110	1860	1750	1660	
3	990	1310	1410	1360	
2	630	970	900	1010	
1	110	200	130	200	

Table III

Holding Power-Holes Parallel to the Grain.

Seasoned White Oak.				
Depth in Inches.	Holding Power in Lbs.			
	15/16"	14/16"	13/16"	12/16"
6	4000	5350	3770	5430
5	2230	3110	2320	3090
4	1200	2420	1740	2370
3	800	1440	1450	2170
2	220	1070	1070	1170
1	0	500	410	390

Seasoned White Pine.				
Depth in Inches	Holding Power in Lbs.			
	15/16"	14/16"	13/16"	12/16"
6	1000	830	1100	940
5	670	720	740	780
4	430	540	600	680
3	200	390	520	450
2	120	110	290	200
1	0	50	0	60

Table IV.

Best Ratio of Diameters of Hole and Bolt.

Holes Transverse to the Grain.

Wood	Depth of Hole	Started – Lbs.				
		15/16"	14/16"	13/16"	12/16"	11/16"
Oak	12"	18550	28000	28200	29310	30870
Pine	12"	6000	8910	8970	7310	——
H.P. per Lin. Inch	Oak	1546	2330	2350	2442	2572
	Pine	500	742	747	609	——

Ave. Holding Power = 2268 – Oak.
649 – Pine.

Best Ratio = 11:16 – Oak
13:16 – Pine

Holes Parallel to the Grain.

Wood	Depth of Hole	Started – Lbs.				
		15/16"	14/16"	13/16"	12/16"	11/16"
Oak	12"	4000	5330	3770	5430	Blocks
Pine	12"	1000	830	1100	940	Split.
H.P. Per Lin. Inch	Oak	666	888	628	905	——
	Pine	166	138	183	156	——

Ave. Holding Power = 771 Oak
161 Pine

Best Ratio = 12:16 – Oak.
13:16 – Pine.

Best Ratio between Diameters of Hole and Bolt.

By referring to the table on the previous page, it is seen that the best ratio of diameters of hole and bolt is 11:16 for oak and 13:16 for pine. In the pine, the block was badly cracked when the rod was driven into the 12/16" hole, and in the 11/16" failed completely. In the oak, however, the bolt driven into a 12/16" hole produced no noticeable failure, and in the 11/16" only slight cracks appeared, which did not prevent the friction from being greater than in the larger holes.

Table V

Comparative Holding Power of Oak and Pine.

Oak

Diam.	15/16"	14/16"	13/16"	12/16"	11/16"
⊥ to Grain	18550	28000	28200	29310	30870
∥ to Grain	4000	5330	3770	5430	——
Ratio	1:4.64	1:5.25	1:7.50	1:5.41	——

Ave. Ratio = 1:5.70

Pine.

Diam	15/16"	14/16"	13/16"	12/16"	11/16"
⊥ to Grain	6000	8910	8970	7310	——
∥ to Grain	1000	830	1100	940	——
Ratio	1:6	1:10.77	1:8.16	1:7.77	——

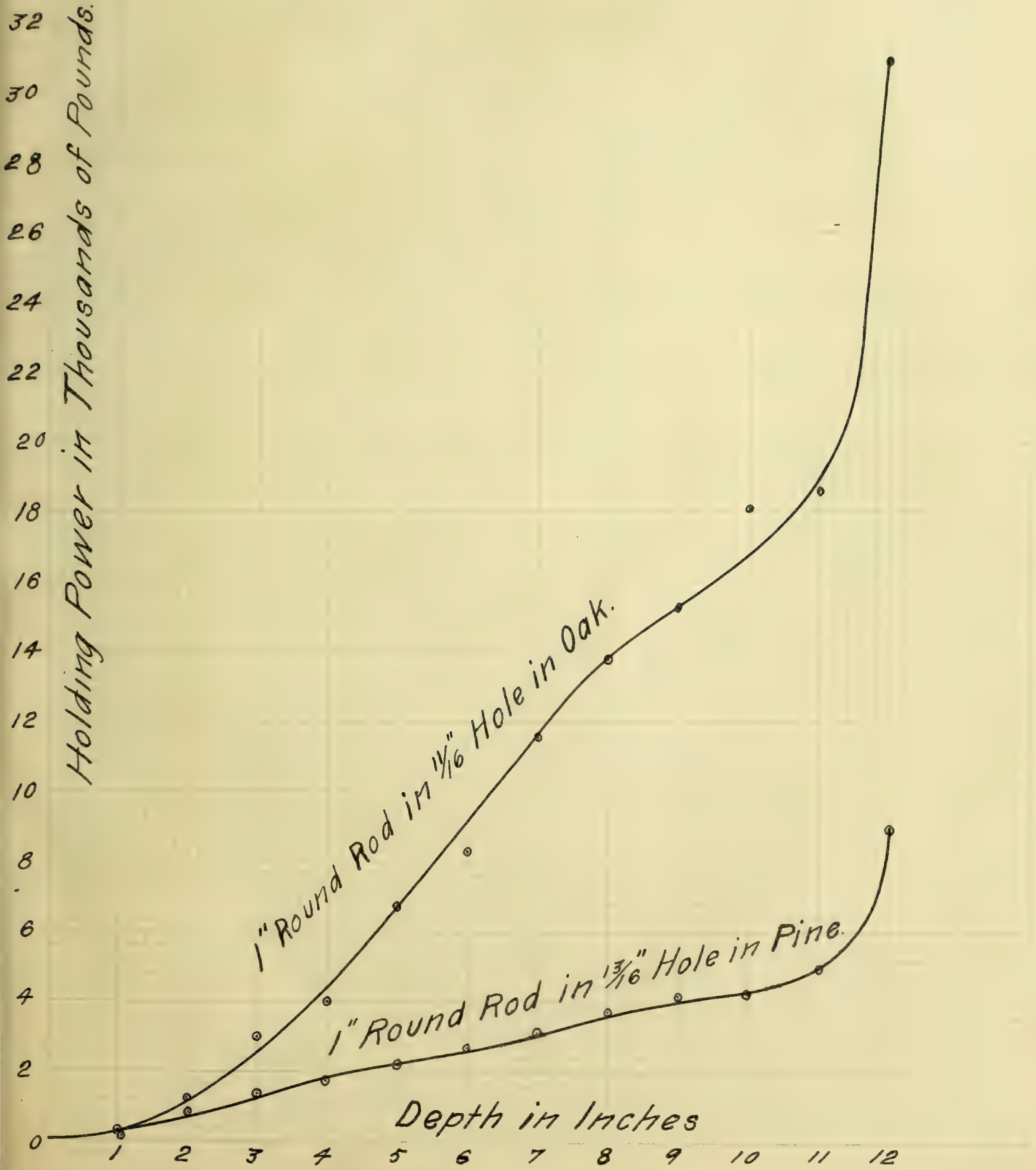
Ave. Ratio = 1:8.17

Comparative Holding Power of Oak and Pine

By reference to the table on the previous page, it is found that the ratio of the holding power in pine to that in oak is almost exactly 1:3 when the holes were perpendicular to the grain. The tests with holes parallel to the grain gave a slightly larger ratio, probably due to the fact that the pine blocks were slightly damaged at the ends in which the $\frac{14}{16}$" and $\frac{12}{16}$" holes were bored.

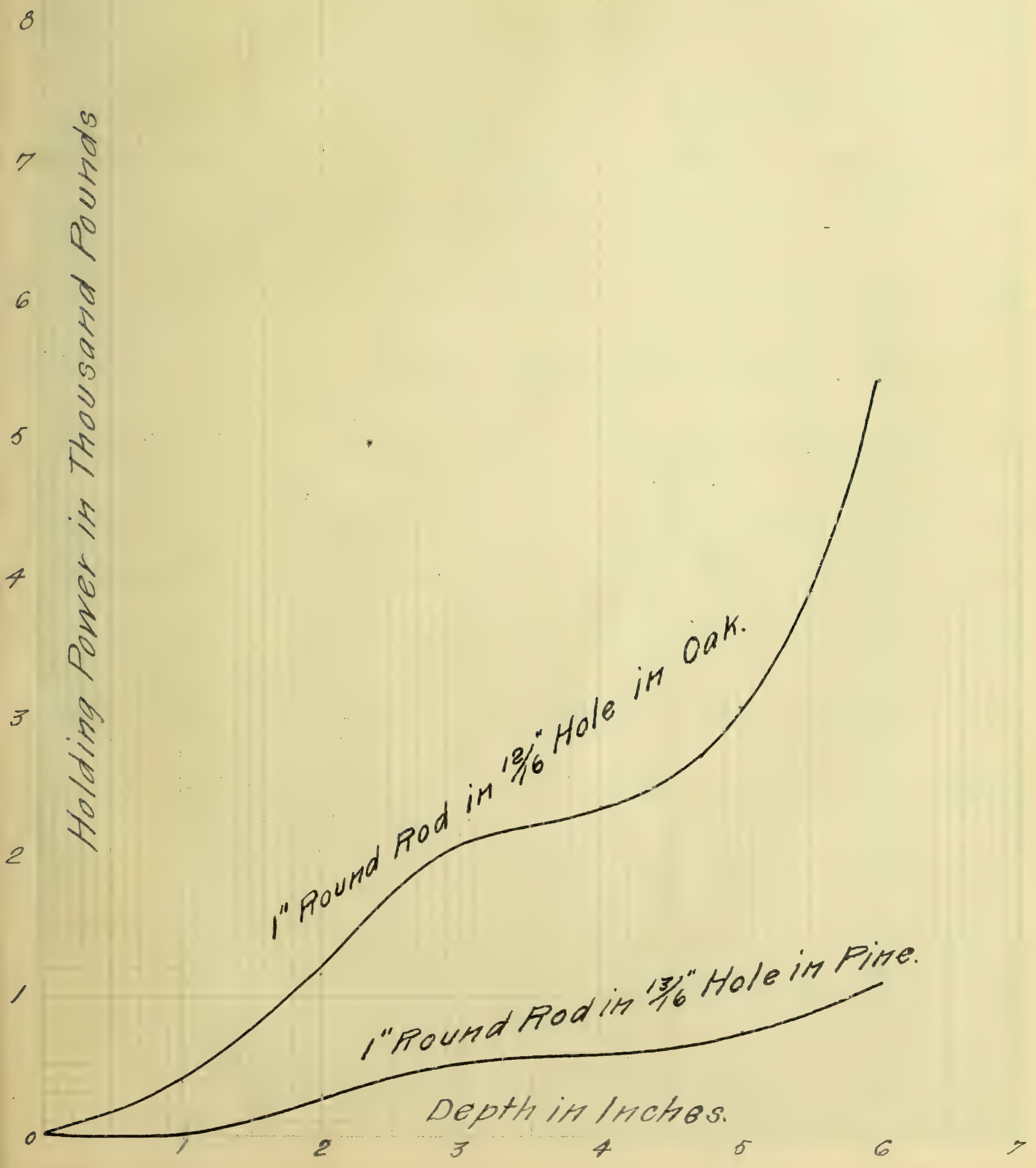
Holding Power
as
Bolts Were Withdrawn

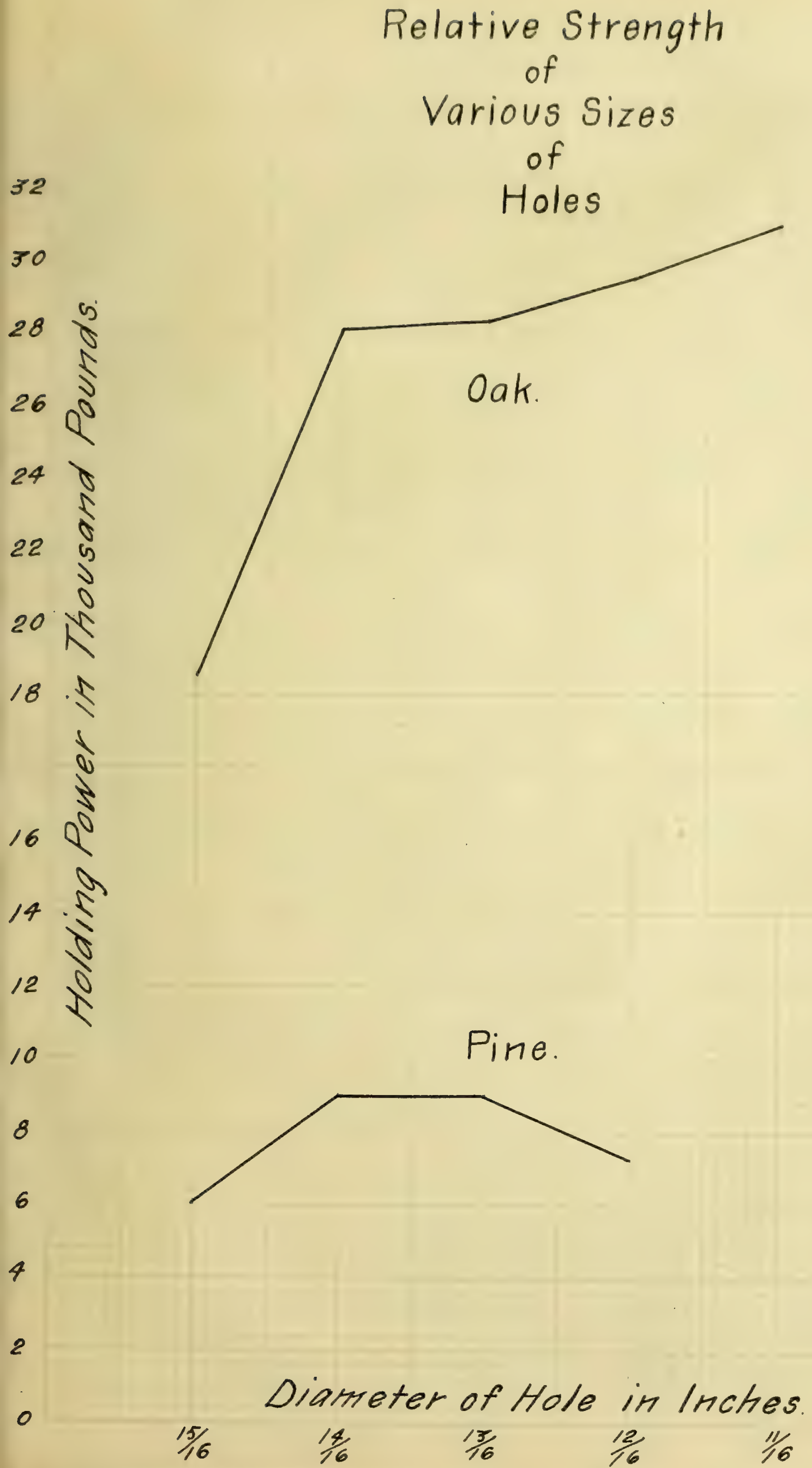
Holes Transverse to Grain



Holding Power as Bolts Were Withdrawn.

Holes Parallel to Grain.




Relative Strength
of
Various Sizes
of
Holes
Oak.
Pine.
Holding Power in Thousand Pounds.
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
Diameter of Hole in Inches.
15/16
14/16
13/16
12/16
11/16

Conclusion.

The results of the fore-going tests agree substantially with the experiments made at the Brooklyn Bridge[1], and with those made by Mr. J. B. Tscharner[2], and also with those made under the direction of General Weitzal[3]. The principal difference is that the writer's experiments gave a slightly greater holding power for the oak as compared with the results of the Brooklyn bridge experiments, and a decrease in the ratio of the holding power parallel to the grain, to that perpendicular to the grain as compared with Mr. J. B. Tscharner's results.

1 Selected Papers: C. E. Club.-1889-90. pp. 53-58.

2. Engineering and Building Record-Nov, 29,'90.

3. Engineering News - Sept, 26. 1891 - pp. 282-3.